CHAPTER

1

General Introduction to Drawing

This chapter provides the background information you need to understand the more advanced concepts that are presented in later chapters. Basic drawing principles, including the different types of drawing views and foreshortening (a technique for making realistic views), are presented here. We also provide an overview of several drawing methods, to show you that making patent drawings is probably easier than you may have anticipated.

Different Drawing Views

Any physical object can be seen from a great variety of view angles—for example, head-on, from the side, from the top, and from the back. Of course, a single drawing, also known as a drawing view or a figure, may show an object only from one view angle. Typically, a single figure cannot show all of the important features or parts of an object, because some of them may be on an opposite side that is not visible in the view. Therefore, when you need to clearly explain the structure of an invention in a patent application, several drawing views may be necessary to show the object from different angles.

Certain view angles have conventional names, so that they can be immediately understood when referred to. Let's look at the most common of these views.

Orthogonal Views

An orthogonal, or engineering, view is one in which the viewer's eyes are centered over a particular side of the object. Put another way, the viewer's line of sight is perpendicular, or orthogonal, to such side. A special object—especially created to look different from every side—is shown in perspective at the top of Illustration 1.1 and is shown below the perspective view in all possible orthogonal views, as described here.

Front Side or Front Elevational View. Shows the front side from a viewpoint centered over the front side.

Rear Side or Rear Elevational View. Shows the rear side from a viewpoint centered over the rear side.

Left Side View or Left Elevational View. Shows the left side from a viewpoint centered over the left side.

Right Side View or Right Elevational View. Shows the right side from a viewpoint centered over the right side.

Top Side View or Plan View. Shows the top side from a viewpoint centered over the top side.

Bottom Side View. Shows the bottom side from a viewpoint centered over the bottom side.

Orthogonal views are relatively difficult to understand because they do not convey a sense of depth, so the shapes of many surfaces appear ambiguous. Despite such a shortcoming, orthogonal views are commonly used in patent drawings because they are relatively simple to make. If one of the orthogonal views is considered alone, without the benefit of the other views, the true shape of the object cannot be deciphered. Such ambiguity is shown in Illustration 1.2. An object that appears as a rectangle in an orthogonal view may have many possible true shapes. Therefore, if an orthogonal view does not convey the shape of an object clearly enough, it should also be shown in one or more perspective views.

Perspective Views

A perspective view is one that shows the three dimensions of an object on a two-dimensional surface; it is not orthogonal to or centered over any side. When the view angle is properly selected, it presents an object as it would be seen in real life by a casual observer. It conveys

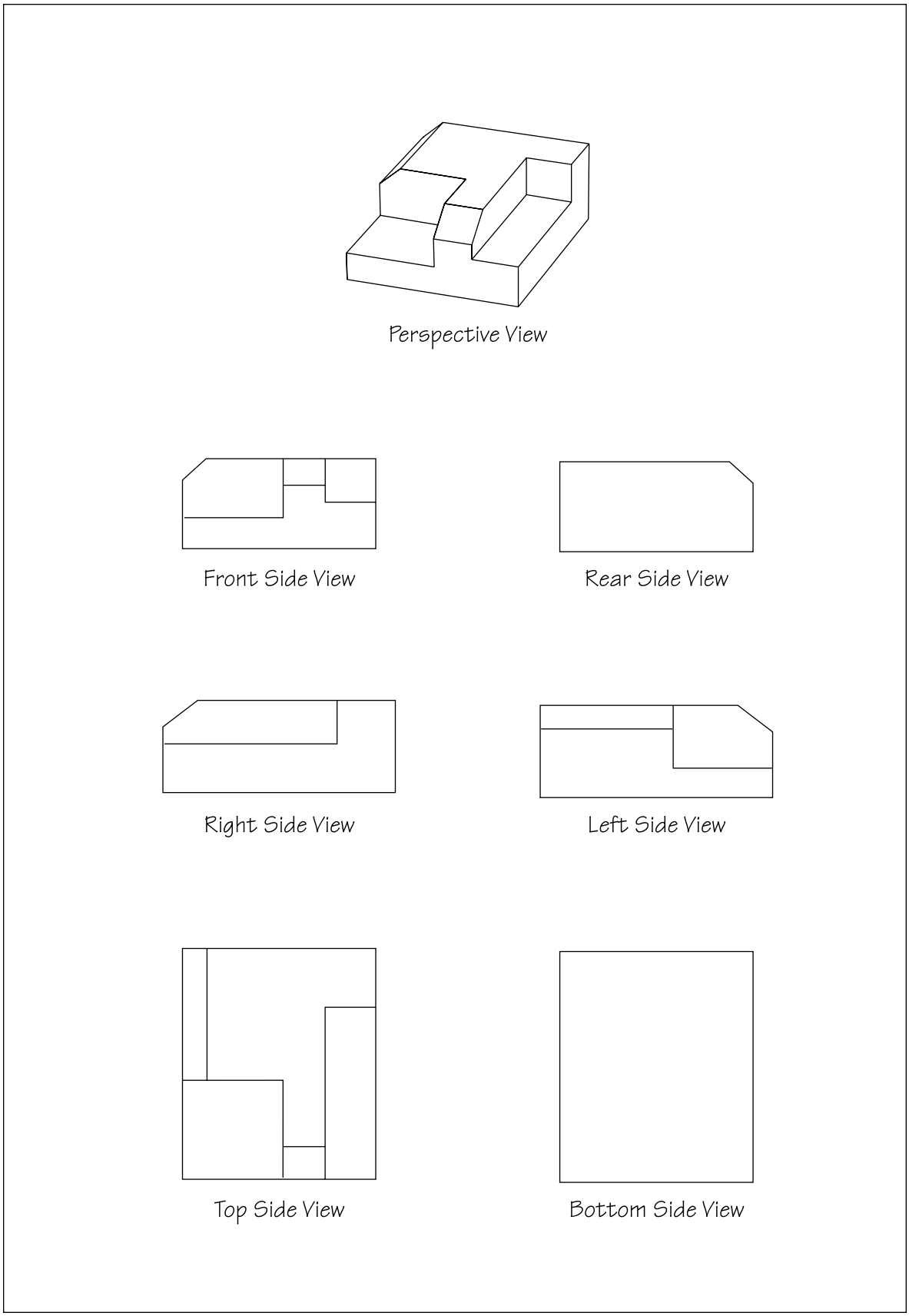
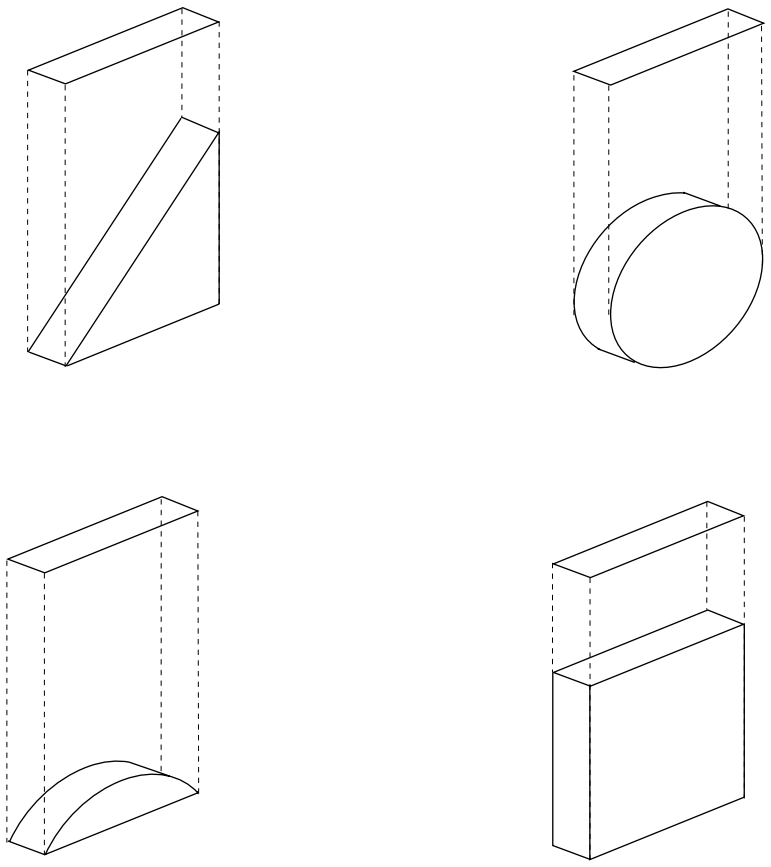


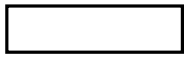
Illustration 1.1—Orthogonal Views

Shape of Orthogonal View



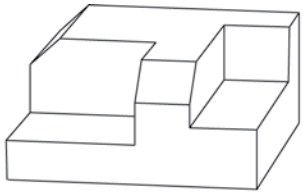
True Shapes

All these shapes appear to be identical in a top view.

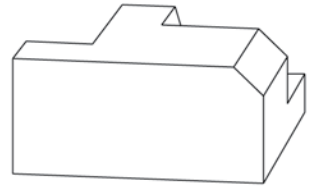


Top View

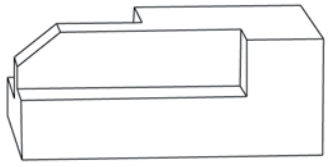
Illustration 1.2—Orthogonal View May Be Ambiguous



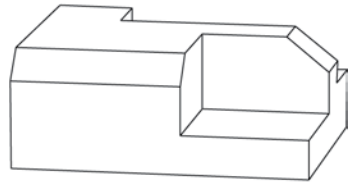
Front Perspective View



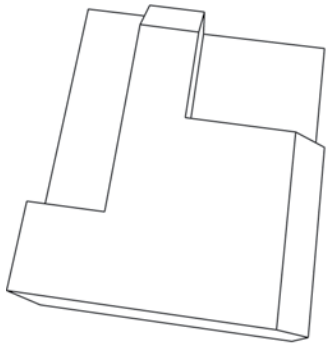
Rear Perspective View



Right Perspective View



Left Perspective View



Top Perspective View

Bottom Perspective View

Illustration 1.3—Perspective Views

a good sense of depth, so that it is much easier to understand than orthogonal views. The special object of Illustration 1.1 is shown in typical perspective views in Illustration 1.3, which includes those described below.

Front Perspective View. Shows the front side somewhat angled away.

Rear Perspective View. Shows the rear side somewhat angled away.

Right Perspective View. Shows the right side somewhat angled away.

Left Perspective View. Shows the left side somewhat angled away.

Top Perspective View. Shows the top side somewhat angled away.

Bottom Perspective View. Shows the bottom side somewhat angled away.

Variations of a Perspective View

If the two sides of an object are equally visible—for example, the top and front—then it may be called either a top perspective or a front perspective view. The view angle of any particular perspective view may be varied. Using the same special object of Illustration 1.1, some variations on the front perspective views are shown in Illustration 1.4, including those described below.

Front Perspective View (from above). Shows the front from a higher viewpoint off to one side.

Front Perspective (from the same level). Shows the front from a viewpoint off to one side, but at the same level. Such a view is almost as ambiguous as the front orthogonal view, so it is not recommended.

Front Perspective (from below). Shows the front from a lower viewpoint off to one side.

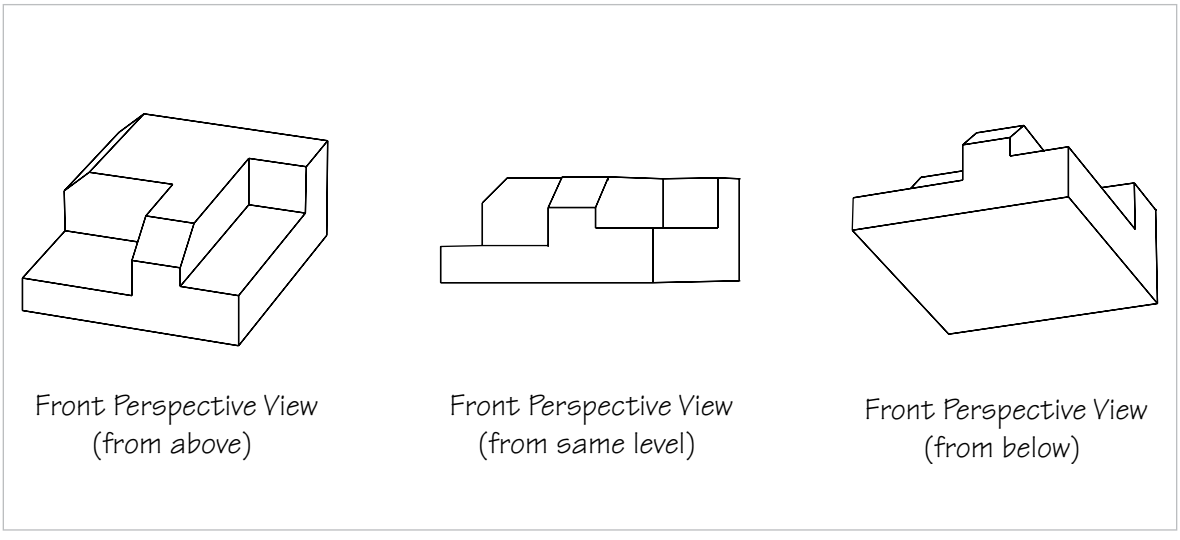


Illustration 1.4—Variations of the Same Perspective View

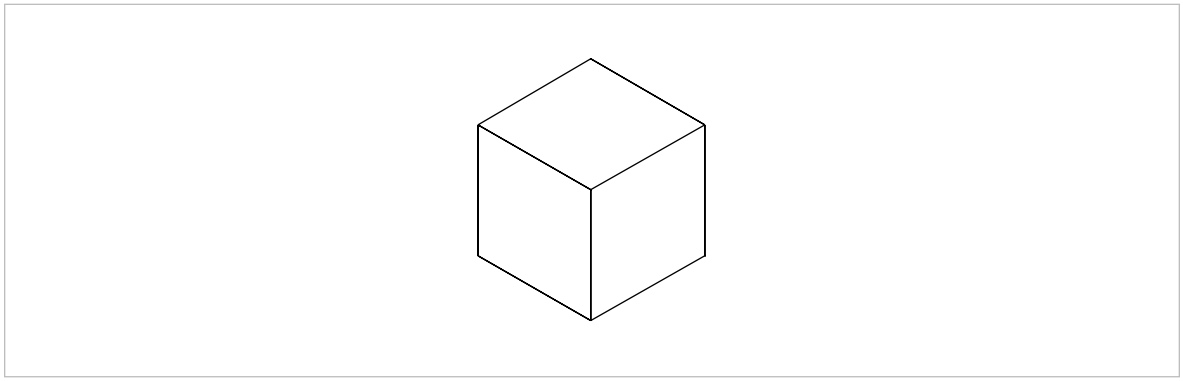


Illustration 1.5—Isometric View

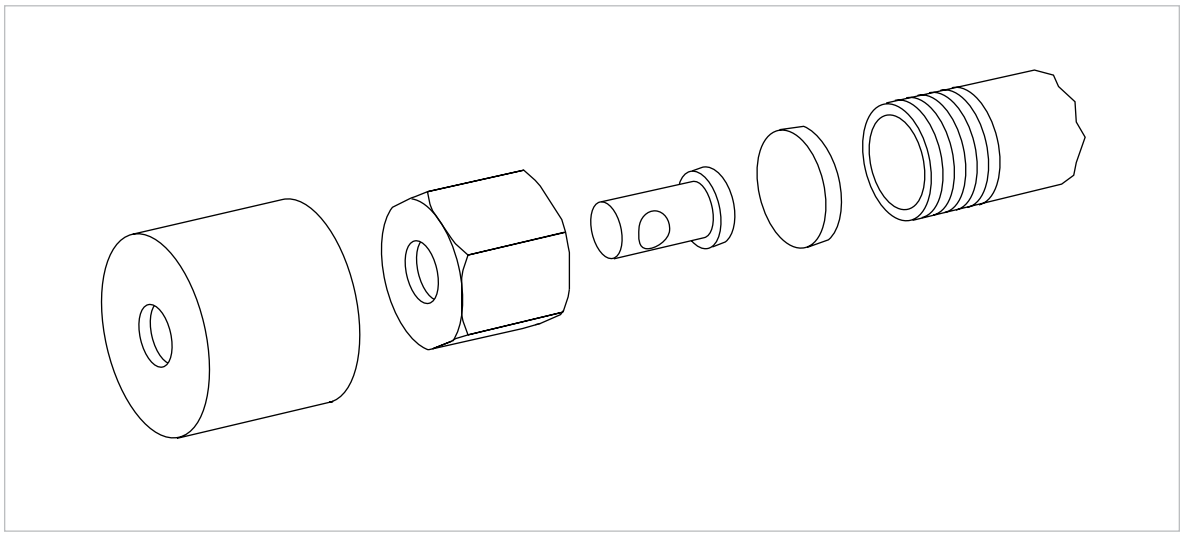


Illustration 1.6—Exploded View

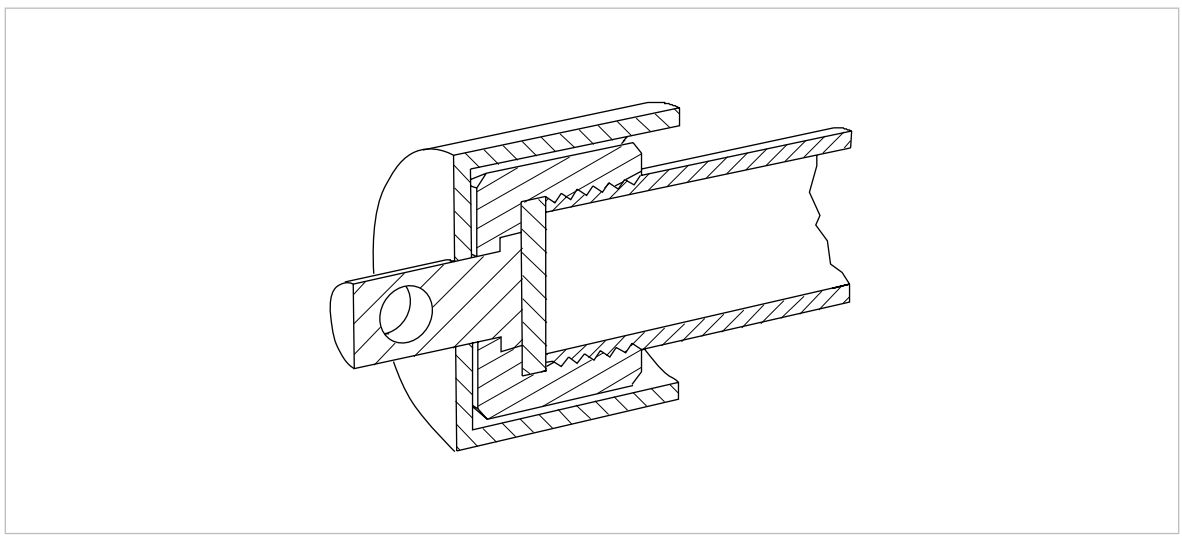


Illustration 1.7—Sectional View

One particular type of perspective view is the isometric (iso = equal; metric = measurement) view, from which the viewer's eyes or viewpoint is positioned exactly between three orthogonal views, as illustrated by the simple cube in Illustration 1.5.

Other types of drawing views include the following two.

Exploded View. The parts of a device can be disassembled and spread apart in space to show otherwise hidden features, as pictured in Illustration 1.6, a water pipe fitting. Exploded views may be orthogonal or perspective. For example, there can be a front exploded view, a side exploded view, and so on.

Sectional View. Part of an object can be sliced away to show interior structures. Sectional views may also be orthogonal or perspective. For illustration, there can be a front sectional view, a side sectional view, a front perspective sectional view, and so on. The view shown in Illustration 1.7 is a side perspective sectional view of the water pipe fitting of Illustration 1.6.

Perspective Foreshortening

In real life, objects in the distance appear smaller than similar objects up close. The same principle also applies to a single, three-dimensional object: Its far end appears smaller than its near end, and its parallel edges appear to converge. The closer you are to the object, the greater the effect appears. To see the effect very clearly, put a long rectangular object, such as a toothpaste box, very close to your eyes. You will notice that its far end appears much smaller than its near end, and that its parallel edges appear to converge.

The technique of representing such an effect in a drawing is known as foreshortening. It is applied to perspective views to make them more realistic. The next time you go to a museum or look at an art book, compare earlier medieval paintings, which were done without foreshortening (it hadn't been invented yet!), to the later Renaissance paintings, which were done with foreshortening. You will see that the medieval paintings appear flat and somewhat cartoon-like, whereas Renaissance paintings are much more realistic representations of people and things.

The degree of foreshortening is inversely proportional to the viewing distance. That is, an object seen from a short distance is drawn with more foreshortening, and an object seen from a greater distance is drawn with less foreshortening. Using the same toothpaste box, you can see that it appears highly foreshortened when it is very close to your eyes and not foreshortened at all when it is far away.

No Foreshortening Versus Excessive Foreshortening

Illustration 1.8 shows a square box drawn without foreshortening, and also with different degrees of foreshortening. The box drawn without foreshortening represents its appearance as seen from a great distance. Its parallel edges are drawn as perfectly parallel lines, so this view is also known as a parallel view. Without foreshortening, the box actually appears slightly distorted.

The middle box, drawn with excessive foreshortening, represents its appearance as seen from an extremely short viewing distance, such as when it is positioned right up against your eyes. Although excessive foreshortening causes the box to appear greatly distorted, it clearly shows how foreshortening is applied: The parallel edges of the box are drawn as converging lines that, if extended, will intersect at points known as "vanishing points." The vanishing points on the sides lie on the horizon (a horizontal line), and the central vanishing

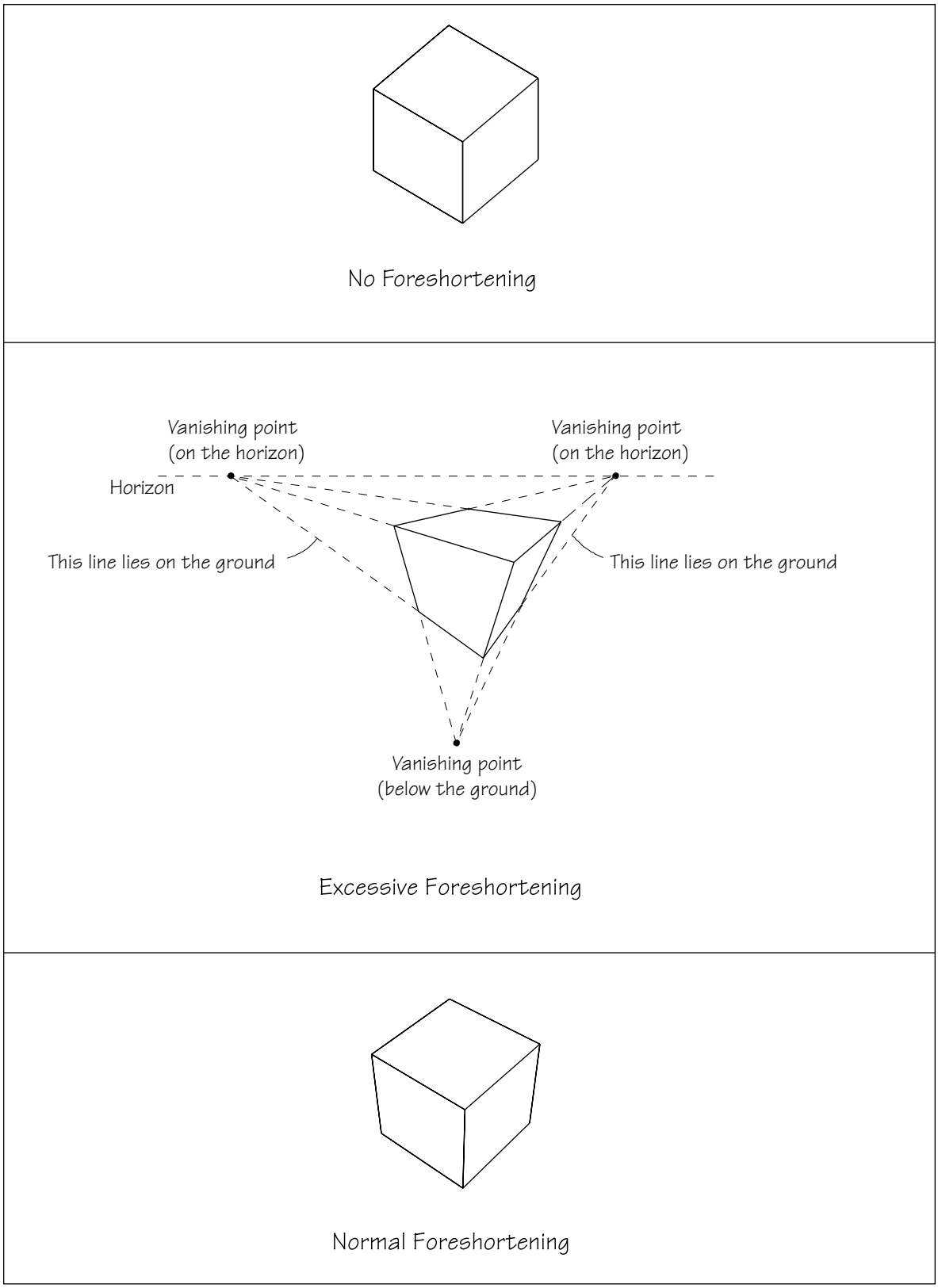


Illustration 1.8—Foreshortening

point lies below "ground level." In the illustration shown, the box is being seen from above.

Realistic Foreshortening

The bottom box is most realistically illustrated with normal foreshortening, that is, a small degree of foreshortening, which represents the object as seen from a normal viewing distance. The parallel edges are drawn as slightly converging lines. The vanishing points of such slightly converging lines are far off the page, so they are not shown.

The rule of thumb is that the greater the foreshortening, the closer the vanishing points are positioned, and the lesser the foreshortening, the farther the vanishing points are positioned. A drawing without foreshortening has no vanishing points, because parallel edges are drawn as parallel lines, which do not converge.

Drawings done with normal foreshortening are the most realistic, but drawings done without foreshortening (parallel views) are perfectly acceptable for patent drawings. Foreshortening is a difficult technique to apply with pen and rulers, but as discussed in Chapter 3, it is extremely easy to apply with a computer. You can forego foreshortening in patent drawings, but you can make much more attractive marketing brochures if you use it.

Drawing With Pen, Ruler, and Instruments

There are two methods for making patent drawings: the traditional or old way with pens and rulers; and the modern way, with a computer. A set of basic tools for the traditional method can be assembled relatively inexpensively, and making simple drawings is fairly easy. However, with pens and rulers, there is little room for mistake, because, except for very small marks, it is very difficult to correct misplaced ink lines. Nevertheless, with careful planning of drawing positioning (layout) and great care in laying down ink lines, drawing with pens and rulers is still a viable technique. Some professional patent draftspersons still make drawings this way, but most now use computers.

Necessary Tools

The necessary tools include pencils for preliminary sketches, ink drafting pens for drawing ink lines, rulers for making straight lines, triangles for making angled lines, templates for making certain standard shapes, compasses, curve rules for drawing curves, an optional drafting table, and high-quality ink drawing paper.

Pen and Ruler Drawing Techniques

Pens and rulers may be used to make patent drawings in the ways described below.

Drawing From Scratch. You can draw an object by visualizing in detail what it should look like, carefully sketching that image on paper with a pencil, correcting it until it looks about right, and finally inking in the lines. Drawing from scratch requires some basic drawing skills. If you need to learn such skills, you can do some additional reading as suggested at the beginning of Chapter 2, or you can draw with a computer instead, which eliminates the need for traditional drawing skills.

Tracing. Tracing is much easier than drawing from scratch. An obvious method is to trace a photograph of an object that you wish to draw, as shown in Illustration 1.9. An actual, three-dimensional object can also be traced by using a device called a camera lucida, available at art supply stores, which projects an image of the object onto a drawing surface. As shown in Illustration 1.10, you may also

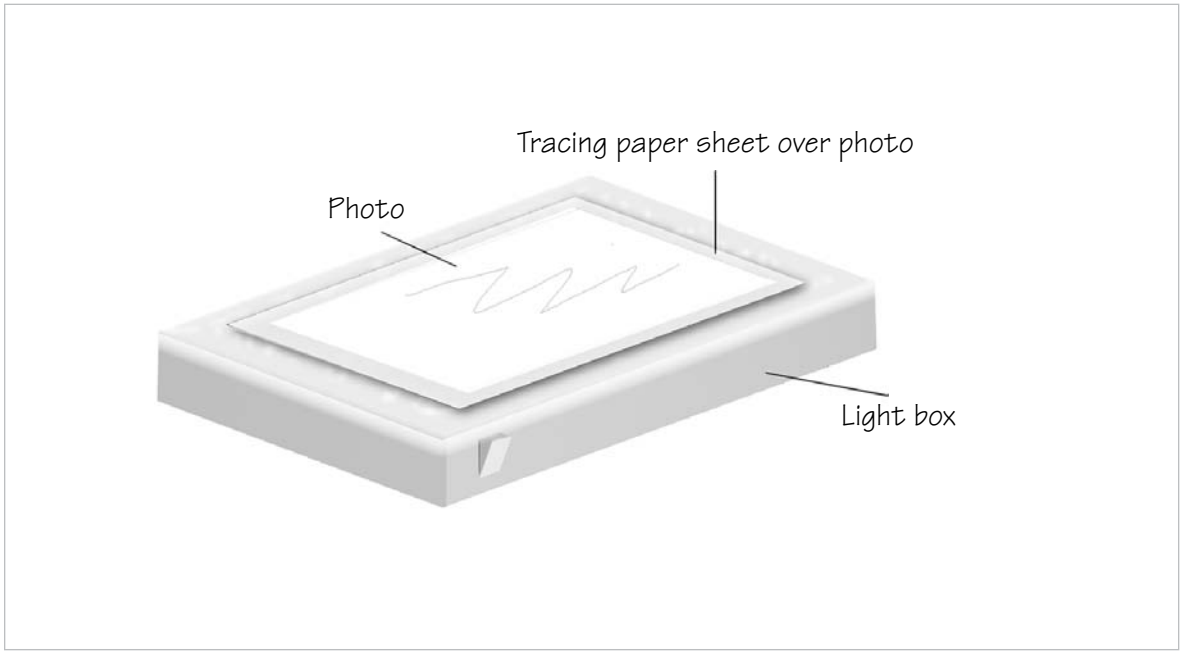


Illustration 1.9—Tracing a Photo

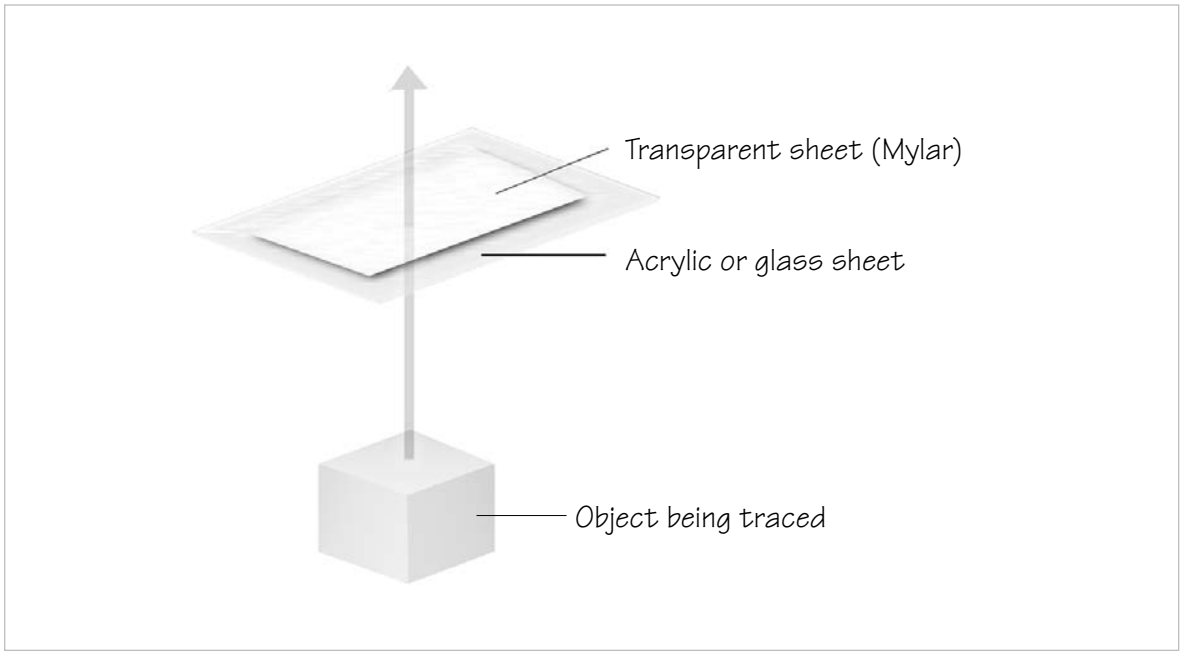


Illustration 1.10—Tracing an Actual Object

trace an actual object—again, we use a simple box to illustrate—by positioning a transparent drawing sheet on a transparent sheet of glass or acrylic, looking at the object through the glass, tracing the lines of the object on the drawing sheet, and photocopying the tracing onto a sheet of paper. This technique is discussed in greater detail in Chapter 2. Tracing requires very little skill other than a steady hand.

Drawing to Scale. You can also draw by scaling —that is, reducing or enlarging—the dimensions of an object to fit on a sheet of paper and draw the lines with exact scale dimensions. For example, if an object has a height of 20 inches and a width of 12 inches, you can reduce those dimensions by 50%, so that you would draw it with a height of 10 inches and a width of 6 inches on paper, as shown in Illustration 1.11. All other dimensions of the object are scaled accordingly for the drawing. One easy way to scale an object is to photograph it and then reduce or enlarge the print using a photocopier. Making a drawing that looks right is easier by drawing to scale than by drawing based on only a mental image.

The techniques and tools for drawing with pens and rulers are explained in greater detail in Chapter 2.

Drawing With a Computer

CAD (computer-aided drafting or design) has been around since the early 1970s. When we refer to CAD (sometimes known as CADD), we're talking about software programs used by inventors, architects, and other design professionals to visualize inventions, products, tools, machinery, and other devices. CAD programs provide a way of modeling these products in 2D or 3D perspectives. Originally, these programs were affordable only to design professionals, but nowadays, powerful CAD software programs are within the price range of just about anyone who owns a computer. In addition, modern CAD software is easier to use than earlier versions.

CAD allows you to produce accurate drawings even if you consider yourself to have little or no artistic ability. In fact, no drawing skills in the traditional sense are needed at all. Furthermore, CAD enables you to correct mistakes as easily as a word processor enables you to edit words in a document. Even if you discover a mistake after you print a drawing, you can easily correct the mistake and print a new copy. To use CAD, you will need some computer skills, but if you know how to type letters on your computer, you can easily learn how to draw with it.

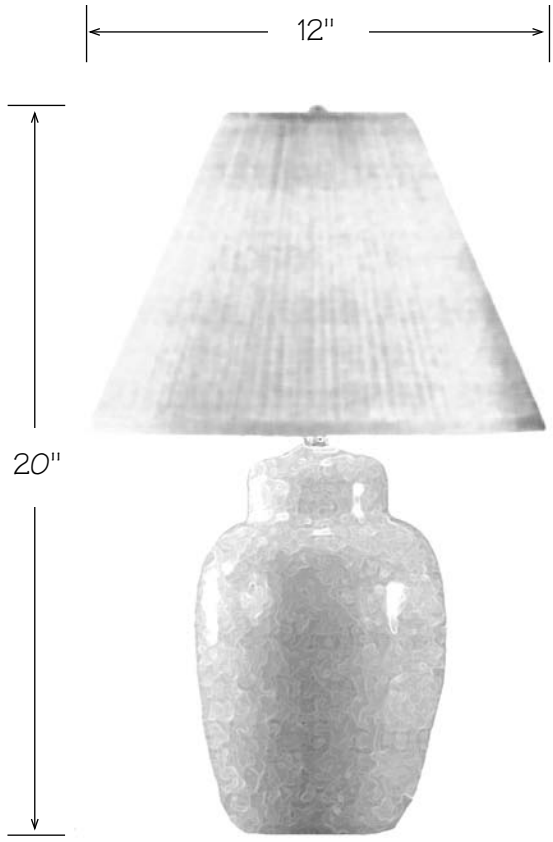
Equipment

You will need a computer, an ink jet or laser printer, a CAD program, an optional scanner, and an optional digital camera.

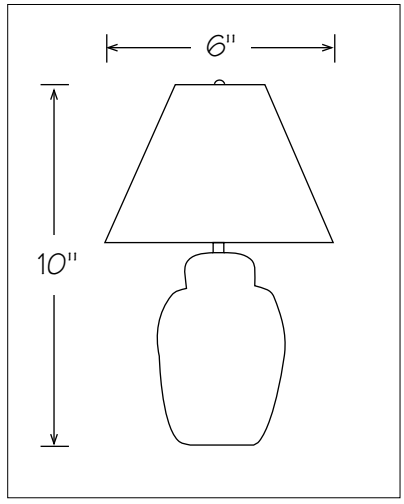
Computer Drawing Techniques

A computer may be used to make patent drawings in the ways described below.

Tracing. If you have a scanner, you can scan a photograph of an object, import (load) the scanned image into a CAD program, and trace it easily, as shown in Illustration 1.12, a photo of an aircraft. (Although difficult to see in a black-and-white book, the black outlines are the tracing lines.) If you have a digital camera, you can take a photograph of the object and download (transfer) the image directly into your computer through a cable, without having to print and scan the photograph. Once it is in your computer, tracing the image is very easy. Since you use a mouse instead of an ink pen, you don't even need a steady hand.



Actual Object



Drawing

Illustration 1.11—Drawing to Scale

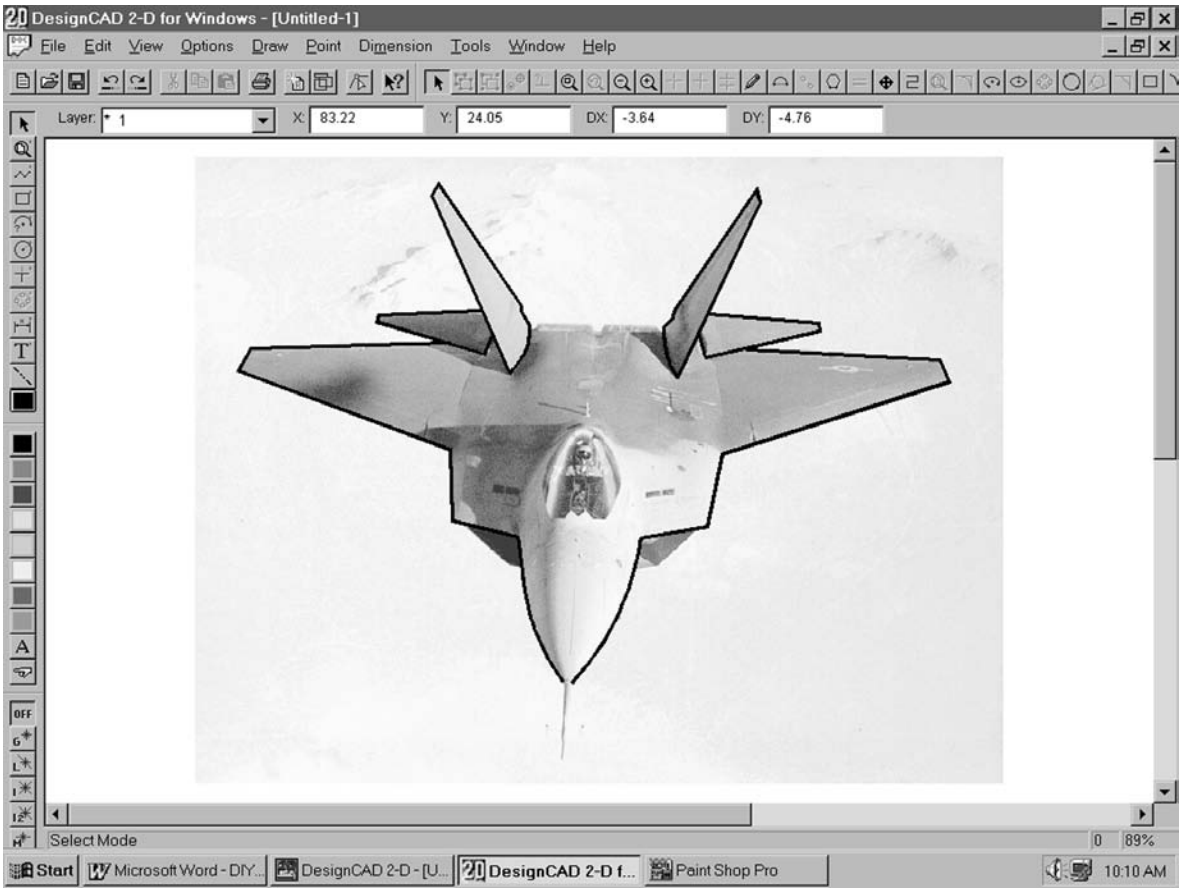


Illustration 1.12—Tracing a Photo on a Computer

Drawing From Scratch. A CAD program will enable you to construct an accurate, three-dimensional (3D) representation of your invention within the computer. A 3D model is typically made by using and modifying basic geometric building blocks, such as boxes, cylinders, planes, and custom-defined shapes. You may create each part with specific dimensions, or you may simply draw a shape that looks about right. You can easily rotate the finished model to see it from any angle. You can also easily zoom in or out to adjust the viewing distance, which is equivalent to adjusting the degree of foreshortening (in CAD, the term "viewing distance" is used instead of "foreshortening"). Once you are satisfied with the view, you can print it as a line drawing (a drawing of dark lines on a light background). Therefore, you can make wonderful looking drawings with a computer, even if you consider yourself to be a terrible artist.

These techniques and tools are explained in greater detail in Chapter 3.

Using a Camera

Almost everyone has some degree of familiarity with photography. Obviously, a camera can take an accurate photograph or "drawing" of an object. While photographs may no longer be submitted as patent drawings (except in special circumstances that will be explained in Chapter 4), they can be converted into suitable patent line drawings by tracing them. To do

so, you must have a basic understanding of photographic lighting and exposure.

Equipment

To take accurate photographs, you will need a digital (preferred) or 35 mm film camera. Your camera should have optical zoom and macro (close up) capabilities. You will also need a tripod.

Taking Pictures

There are mountains of books on photographic techniques, and cameras typically come with booklets on basic techniques, so we will not go into great detail. We will cover a few simple techniques in Chapter 4 that will enable you to take pictures good enough for tracing (and for filing as patent drawings when permitted).

Tracing Pictures

A photograph can be converted into a line drawing by putting a piece of paper over it and tracing it with a pencil, or by scanning it into a computer and tracing it with a CAD program.

Summary

As you can see, there are two ways to make patent drawings. If you favor one of them, you may go directly to the chapter that discusses it in detail. Otherwise, a reading of the following chapters will help you select the technique that is right for you.